Form PTO-1390 P21932.P01	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER P21932
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 10/030133

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/07076	24 July 2000	26 July 1999

TITLE OF INVENTION

X-RAY ANODE AND PROCESS FOR ITS MANUFACTURE

APPLICANT(S) FOR DO/EO/US

Matthias FRYDA, Lothar SCHAEFER, and Thorsten MATTHEE

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. _X_ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ___ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. _X_ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. _X_ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. _X_ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. _X_ is attached hereto (required only if not communicated by the International Bureau).
   b. _X_ has been communicated by the International Bureau.
   c. ___ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ___ An English language translation of the International Application as filed (35 U.S.C. 371 (c)(2)).
7. ___ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ___ are attached hereto (required only if not communicated by the International Bureau).
   b. ___ have been communicated by the International Bureau.
   c. ___ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ___ have not been made and will not be made.
8. ___ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3))
9. _X_ An oath or declaration of the inventor(s) (35 U.S.C. .371(c)(4)).
   "Executed"
10. ___ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (U.S.C. 371(c)(5)).

Items 11 to 16 below concern other document(s) or information included:

11. Assignee: FRAUNHOFER-GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG e.V. of München, GERMANY
12. ___ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
13. _X_ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
14. ___ A FIRST preliminary amendment.
    ___ A SECOND or SUBSEQUENT preliminary amendment.
15. ___ A substitute specification.
16. ___ A change of power of attorney and/or address letter.
17. ___ Figure of Drawing to be published_____
18. _X_ Other items or information:
    PCT/RO/101-PCT Request(in German).
    PCT/IPEA/401(in German).
    PCT/IPEA/408(in German).
    PCT/IPEA/416(in German).
    PCT/IPEA/409-with three sheets of amended pages(in German).
    International Application as published Cover Sheet(in German).
    PCT/IB/301.
    PCT/IB/304.
    PCT/IB/308.
    PCT/ISA/220(in German).
    PCT/ISA/210(in German).
    Claim of Priority.

531 Rec'd PCT/PTC 25 JAN 2002

U.S. APPLICATION NO (If known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/030133	PCT/EP00/07076	P21932

19. _X_ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)):		
Search report has been prepared by the EPO or JPO. . . . . $ 890.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482). . . . . $ 710.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO(37 CFR 1.445(a)(2). . . . . $ 740.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO. $1,040.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4). . . . . $ 100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ___ 20 ___ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	RATE		
Total Claims	- 20 =		X $18.00	$	
Independent Claims	- 3 =		X $84.00	$	
Multiple dependent claim(s) (if applicable)			+ $280.00	$	
			TOTAL OF ABOVE CALCULATIONS =	$890.00	
___ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.				$	
			SUBTOTAL =	$890.00	
Processing fee of $130.00 for furnishing the English translation later than ___ 20 ___ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).			+		
Extension of Time fee in the amount of $					
			TOTAL NATIONAL FEE =	$890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property			+	$40.00	
			TOTAL FEES ENCLOSED =	$930.00	
				Amount to be refunded	$
				Charged	$

a. _X_ A check in the amount of $930.00 to cover the above fees is enclosed.

b. ___ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees.

c. _X_ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-0089.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO **CUSTOMER NO. 7055**
AT THE PRESENT ADDRESS OF:
Neil F. Greenblum
GREENBLUM & BERNSTEIN, P.L.C.
1941 Roland Clarke Place
Reston, VA 20191
(703) 716-1191

07055
PATENT TRADEMARK OFFICE

SIGNATURE
Neil F. Greenblum
NAME

28,394
REGISTRATION NUMBER

P21932.A01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants	:	Matthias FRYDA et al.	)
			) Applications Branch
Appln. No.	:	10/030,133	)
			)
Filed	:	January 25, 2002	)
			)
For	:	X-RAY ANODE AND PROCESS FOR ITS MANUFACTURE	

PRELIMINARY AMENDMENT AND COVER LETTER SUBMITTING AMENDED PAGES OF APPLICATION

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

A copy of the International Preliminary Examination Report - Form PCT/IPEA/409 (hereinafter "Report"), was submitted to the Examiner on January 25, 2002. Applicants note that this Report was drawn on pages of description 1 - 7 and 1 sheet of drawings as originally filed, replacement claims 2 - 16 as filed September 5, 2001, and replacement claim 1 as filed November 13, 2001, and includes as an Annex replacement claims 1 - 16 (in German) submitted September 5, 2001 and replacement claim 1 (in German) submitted November 13, 2001. For the Examiner's convenience, an English translation of the Annex is submitted herewith, in which each sheet is identified on the bottom of the page as "MODIFIED SHEET" along with the submission date of the specific sheet.

Based upon the submission of the modified sheets of claims, Applicants respectfully request examination on the merits of the application containing pages of description 1 - 7 and 1 sheet of drawings as originally submitted and replacement claims 2 - 16 submitted September 5, 2001 and replacement claim 1 submitted November 13, 2001 (in place of originally filed claims 1 - 22).

Additionally, prior to the examination of the above-identified application including replacement claims 1 - 16, amendment of specification and claims as follows:

IN THE SPECIFICATION

Please amend the paragraphs as follows (Marked-up copies of the amended paragraphs are attached as an Appendix):

Please replace paragraph [0002] with the following amended paragraph:

[0002] In x-ray production, metallic anode material is usually irradiated with electrons. The radiation caused by characteristic electronic transitions exits the apparatus through a window transparent for x-rays. In order to avoid absorption, X-ray production results here at low gas pressures. The transparent window serves to separate the low pressure area from the outside area.

Please replace paragraph [0010] with the following amended paragraph:

[0010] However, it has been possible to prove with experiments that these disadvantages could be overcompensated by a diamond substrate. Contrary to expectations, it is possible to work with a much smaller focus with an x-ray anode on a diamond window than it is with

an x-ray anode on a beryllium window. The reason for the overcompensation is that diamond is an excellent heat conductor, so the thermal energy produced can be dissipated with particular efficiency through the diamond substrate. The focal spot therefore heats up less and it is possible to decrease the focus diameter. This leads, as desired, to greater radiation densities. Conversely, exchanging a diamond window for the beryllium window with the same beam density and operating life renders possible a thinner anode with lower absorption of x-radiation.

IN THE CLAIMS

Please amend the claims as follows (Marked-up copies of the amended claims are attached as an Appendix):

4. (Amended) X-ray anode according to claim 1, characterized in that the anode material is a metal, an alloy or several layers of metal.

5. (Amended) X-ray anode according to claim 1, characterized in that the anode material thickness is between 1 μm and 25 μm.

8. (Amended) X-ray anode according to claim 1, characterized in that the anode material completely covers the window.

9. (Amended) X-ray anode according to claim 1, characterized in that the anode material partially covers the window.

10. (Amended) X-ray anode according to claim 1, characterized in that an intermediate layer is provided between the x-ray anode and the diamond window.

11. (Amended) X-ray anode according to claim 1, characterized in that the intermediate layer is an adhesion-promoting layer.

12. (Amended) X-ray anode according to claim 1, characterized in that the intermediate layer is a radiation filter.

13. (Amended) X-ray anode according to claim 1, characterized in that a temperature sensor is provided.

15. (Amended) Use of an x-ray anode according to claim 1 for x-ray microscopes.

16. (Amended) Use of an x-ray anode according to claim 1 for x-ray units.

REMARKS

Entry of the foregoing replacement sheets upon which the International Preliminary Examination Report is based and amendment of the specification and claims are respectfully requested. Applicants note that the instant amendments have been made to generally improve the form of the application and remove multiply dependent claims prior to the calculation of fees.

P21932.A01

Should there be any questions, the Examiner is invited to contact the undersigned at the below listed number.

Respectfully submitted,
Matthias FRYDA et al.

Neil F. Greenblum
Reg. No. 28,394 #35,043

March 19, 2002
GREENBLUM & BERNSTEIN, P.L.C.
1941 Roland Clarke Place
Reston, VA 20191
(703) 716-1191

APPENDIX

Marked-Up Copies of the Amended Paragraphs:

Please replace paragraph [0002] with the following amended paragraph:

[0002] In x-ray production, metallic anode material is usually [impinged on] irradiated with electrons. The radiation caused by characteristic electronic transitions exits the apparatus through a window transparent for x-rays. In order to avoid absorption, X-ray production results here at low gas pressures. The transparent window serves to separate the low pressure area from the outside area.

Please replace paragraph [0010] with the following amended paragraph:

[0010] However, it has been possible to prove with experiments that these disadvantages could be overcompensated by a diamond substrate. Contrary to expectations, it is possible to work with a much smaller focus with an x-ray anode on a diamond window than it is with an x-ray anode on a beryllium window. The reason for the overcompensation is that diamond is an excellent heat conductor, so the thermal energy produced can be dissipated with particular efficiency through the diamond substrate. The focal spot therefore heats up less and it is possible to [increase the focus] decrease the focus diameter. This leads, as desired, to greater radiation densities. Conversely, exchanging a diamond window for the beryllium window with the same beam density and operating life renders possible a thinner anode with lower absorption of x-radiation.

Marked-Up Copies of the Amended Claims:

4. (Amended) X-ray anode according to [at least one of claims 1 through 3] claim 1, characterized in that the anode material is a metal, an alloy or several layers of metal.

5. (Amended) X-ray anode according to [at least one of claims 1 through 4] claim 1, characterized in that the anode material thickness is between 1 μm and 25 μm.

8. (Amended) X-ray anode according to [at least one of claims 1 through 7] claim 1, characterized in that the anode material completely covers the window.

9. (Amended) X-ray anode according to [at least one of claims 1 through 8] claim 1, characterized in that the anode material partially covers the window.

10. (Amended) X-ray anode according to [at least one of claims 1 through 9] claim 1, characterized in that an intermediate layer is provided between the x-ray anode and the diamond window.

11. (Amended) X-ray anode according to [at least one of claims 1 through 10] claim 1, characterized in that the intermediate layer is an adhesion-promoting layer.

12. (Amended) X-ray anode according to [at least one of claims 1 through 11] claim 1, characterized in that the intermediate layer is a radiation filter.

13. (Amended) X-ray anode according to [at least one of claims 1 through 12] claim 1, characterized in that a temperature sensor is provided.

15. (Amended) Use of an x-ray anode according to [at least one of claims 1 through 14] claim 1 for x-ray microscopes.

16. (Amended) Use of an x-ray anode according to [at least one of claims 1 through 14] claim 1 for x-ray units.

New Patent Claim 1

1. X-ray anode for microfocus sources in which the anode material is located on a diamond window, characterized in that the thickness of the diamond window is in the range of 300 μm to 2000 μm.

This is followed by the currently valid patent claims 2 through 16.

New Patent Claims

1. X-ray anode, characterized in that the anode material is located on a diamond window, characterized in that the thickness of the diamond window is in the range of 300 μm to 700 μm or in the range of 700 μm to 2000 μm.
2. X-ray anode according to claim 1, characterized in that it is a polychrystalline diamond window.
3. X-ray anode according to claim 1, characterized in that the diamond window is a monocrystal.
4. X-ray anode according to at least one of claims 1 through 3, characterized in that the anode material is a metal, an alloy or several layers of metal.
5. X-ray anode according to at least one of claims 1 through 4, characterized in that the anode material thickness is between 1 μm and 25 μm.
6. X-ray anode according to claim 5, characterized in that the anode material thickness is between 3 μm and 12 μm.
7. X-ray anode according to claim 6, characterized in that the anode material thickness is 6 μm.
8. X-ray anode according to at least one of claims 1 through 7, characterized in that the anode material completely covers the window.
9. X-ray anode according to at least one of claims 1 through 8, characterized in that the anode material partially covers the window.
10. X-ray anode according to at least one of claims 1 through 9, characterized in that an intermediate layer is provided between the x-ray anode and the diamond window.
11. X-ray anode according to at least one of claims 1 through 10, characterized in that the intermediate layer is an adhesion-promoting layer.
12. X-ray anode according to at least one of claims 1 through 11, characterized in that the intermediate layer is a radiation filter.
13. X-ray anode according to at least one of claims 1 through 12, characterized in that a temperature sensor is provided.
14. X-ray anode according to claim 13, characterized in that the diamond window is provided

as a temperature sensor.

15. Use of an x-ray anode according to at least one of claims 1 through 14 for x-ray microscopes.

16. Use of an x-ray anode according to at least one of claims 1 through 14 for x-ray units.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
1. Februar 2001 (01.02.2001)

PCT

(10) Internationale Veröffentlichungsnummer
WO 01/08195 A1

(51) Internationale Patentklassifikation[7]: H01J 35/18

(21) Internationales Aktenzeichen: PCT/EP00/07076

(22) Internationales Anmeldedatum:
24. Juli 2000 (24.07.2000)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
199 34 987.8 26. Juli 1999 (26.07.1999) DE

(71) Anmelder *(für alle Bestimmungsstaaten mit Ausnahme von US)*: **FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.** [DE/DE]; Leonrodstrasse 54, D-80636 München (DE).

(72) Erfinder; und

(75) Erfinder/Anmelder *(nur für US)*: **FRYDA, Matthias** [DE/DE]; Eichendorffstrasse 14, D-38110 Braunschweig (DE). **SCHAEFER, Lothar** [DE/DE]; Moorweg 1, D-38527 Meine (DE). **MATTHEE, Thorsten** [DE/DE]; Wiesenweg 11 A, D-38527 Meine (DE).

(81) Bestimmungsstaaten *(national)*: JP, KR, US.

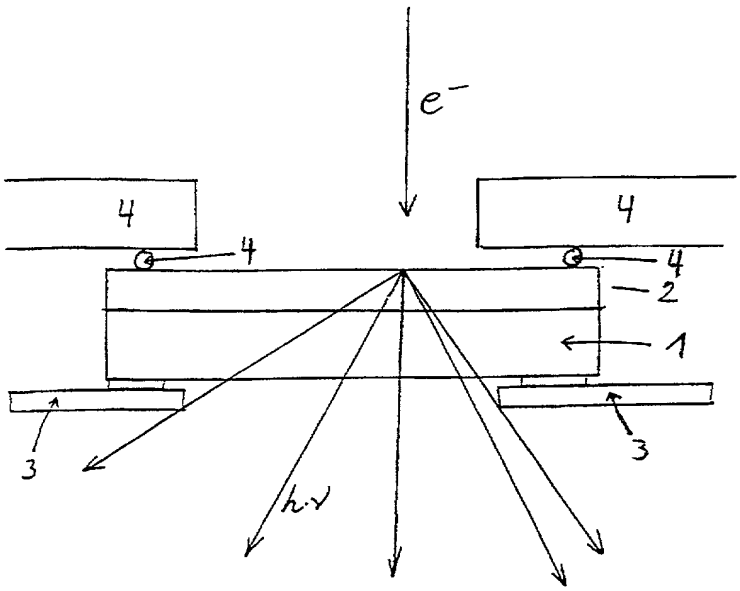
(84) Bestimmungsstaaten *(regional)*: europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Veröffentlicht:
— *Mit internationalem Recherchenbericht.*

[Fortsetzung auf der nächsten Seite]

(54) Title: X-RAY ANODE AND METHOD FOR THE PRODUCTION THEREOF

(54) Bezeichnung: RÖNTGENANODE UND VERFAHREN ZU IHRER HERSTELLUNG



(57) Abstract: The invention relates to an X-ray anode and to a method for the production thereof. The inventive X-ray anode is characterized in that the anode material is located as a layer (2) on a diamond window (1). The X-ray anode is preferably used for X-ray apparatuses where an X-radiation is required that is limited as precisely as possible to a defined point in order to achieve a maximum radiation. The inventive X-ray anode is most preferably used in X-ray microscopes in which a high radiation intensity guarantees maximum resolutions.

[Fortsetzung auf der nächsten Seite]

WO 01/08195 A1

Patent Application:
X-ray anode and Process for its Manufacture

Applicant:
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.

Specification

Technical Field

[0001] The invention relates to an x-ray anode and a process for its manufacture. The x-ray anode according to the invention is preferred for use in x-ray units where the highest possible x-radiation is necessary. It is particularly preferred for use with x-ray microscopes in which a high radiation intensity guarantees the highest resolutions.

Prior Art

[0002] In x-ray production, metallic anode material is usually impinged on with electrons. The radiation caused by characteristic electronic transitions exits the apparatus through a window transparent for x-rays. In order to avoid absorption, X-ray production results here at low gas pressures. The transparent window serves to separate the low pressure area from the outside area.

[0003] Metallic x-ray anodes made of e.g., copper or molybdenum, and a beryllium window in a target angle arrangement are known. There is a certain spacing between the anode and the beryllium window here and they are tilted towards one another. If the x-radiation produced is used for x-ray microscope purposes, this solution has the disadvantage of the resolution being only quite small because of the unavoidable ray divergence between the anode and the object to be imaged. Beryllium is also highly toxic and should therefore be avoided as far as possible as a window material.

[0004] As an alternative to beryllium windows as x-ray exit windows for x-ray units, US 5,173,612 suggests using a diamond window a few 10 μm thick. However, since thicker diamond windows are ruled out because of increased absorption by diamond, these thin diamond windows cause considerable mechanical problems. Thin diamond windows can hardly withstand the pressure differential of approximately 10^5 Pa between the low pressure area and the outside area and have to be stabilized by appropriate crosspieces at considerable cost.

[0005] Also known are so-called microfocus sources, where the anode material forms a layer on a beryllium window and where the anode is bombarded by an electron beam as strongly focussed as possible. In the case of these microfocus sources, the anode moves closer to the object in optical imaging and the optical resolution can be increased. The more sharply the electron beam bombarding the anode is focussed on the anode, the better the resolution. Disregarding diffractions, a spot focus on the anode would be ideal. However, with a spot focus the problem arises that the energy generated by the electron bombardment causes the material to melt or evaporate, thus reducing its operating life. A thicker anode must be selected to compensate for the evaporation of anode material. However, a thick anode results in the x-radiation being absorbed by the anode material itself. The use of a thicker beryllium window is ruled out for the same reason. Moreover, this solution has the considerable disadvantage that mechanical problems can occur due to the existing pressure differentials, and the microfocus source can easily burst. However, this is particularly harmful in the case of toxic beryllium, where a rupture of the microfocus source leads to undesirable apparatus down-time because of the safety measures for staff protection then required. For these reasons according to prior art spot focussing is possible only to a limited extent.

Description of the Invention

[0006] The invention is based on the technical problem of producing an x-ray anode that avoids the disadvantages of the prior art as far as possible. The x-ray anode needs to be harmless from a health viewpoint and, in particular, should make it possible to work with a much smaller focus than with the prior art.

[0007] The solution of this technical problem is achieved through the features listed in claim 1. The process-related task of producing such an x-ray anode is solved by the features of claim 16. Advantageous embodiments are provided in the dependent claims.

[0008] According to the invention it was recognized that the problems could be solved by an x-ray anode where the anode material is on a diamond window.

[0009] At first, diamond seems unsuitable as a material for a microfocus source. With an atomic number of Z=6, diamond absorbs x-radiation more than beryllium at Z=4. It would therefore be expected that the diamond windows used would have to be thinner than beryllium

windows, entailing the above-mentioned mechanical problems. Moreover, up until now, only beryllium was considered as a window material, since beryllium is a rollable metal from which it is easy to make beryllium windows. According to the prior art, this window serves as a substrate for a metal anode to be applied.

[0010] However, it has been possible to prove with experiments that these disadvantages could be overcompensated by a diamond substrate. Contrary to expectations, it is possible to work with a much smaller focus with an x-ray anode on a diamond window than it is with an x-ray anode on a beryllium window. The reason for the overcompensation is that diamond is an excellent heat conductor, so the thermal energy produced can be dissipated with particular efficiency through the diamond substrate. The focal spot therefore heats up less and it is possible to increase the focus. This leads, as desired, to greater radiation densities. Conversely, exchanging a diamond window for the beryllium window with the same beam density and operating life renders possible a thinner anode with lower absorption of x-radiation.

[0011] It has been shown that even relatively thick diamond layers can be used advantageously with very thin anodes. In this context, diamond windows are also suitable with thicknesses of between 50μm and 1000μm, or still better between 300 μm and 700μm. With such thicknesses, an efficient removal of heat and a good mechanical stability is guaranteed.

[0012] According to the present invention, a polycrystalline diamond substrate or diamond window can be used, as well as a monocrystal window. A polycrystalline diamond substrate can be produced particularly simply by means of chemical vapor deposition (CVD), e.g., by hot-filament CVD or microwave CVD. This also makes it possible to produce larger diamond substrates at moderate prices. The deposition of the anode material takes place through a different deposition process, e.g., physical vapor deposition (PVD).

[0013] Basically, metals, several layers of metal, or metal alloys can be considered as anode material. The thickness of the anode material should preferably be in the range of between 1μm and 25 μm, even better in the range of between 3 μm and 12 μm, and best of all at 6 μm.

[0014] The layers do not need to feature constant thicknesses. This means that, e.g., in the case of a disk-shaped microfocus source, the disk thickness does not need to be uniform. The disk can have, e.g., a greater thickness at the edges. The thicknesses given above for the layers should therefore be understood to refer to thicknesses in the focal spot.

[0015] In order to ensure that there is always sufficient anode material on the diamond, and that it has not evaporated after a certain number of hours in operation, a temperature sensor can be provided for the x-ray anode according to the invention. A creative possibility here is using the diamond window as a thermistor, i.e., exploiting the temperature dependence of the electrical resistance of the diamond window. After the appropriate calibration, the user has only to set the optimal operating point regarding the desired radiation intensity with a minimal evaporation rate. This makes it easier to avoid thermally-conditioned damage to the x-ray anode according to the invention. Even in the event that part of the anode material has evaporated after a certain number of hours in operation, the diamond window, as an uncommonly thermally stable material, will usually be completely intact. In this case, the remaining anode material can be chemically removed and the diamond window can be recoated in the course of maintenance work. Choosing diamond as a window material thus renders possible a cost-efficient overhaul of the x-ray anode according to the invention, while simultaneously reusing the diamond window.

[0016] In its simplest embodiment, the anode material is found holohedrally on the diamond substrate. Depending on the special features of production or of the planned use for the microfocus source, however, it can be sufficient for only part of the diamond layer to be covered by the anode material. Depending on the adhesion of the anode material to the diamond substrate, it can be sufficient to apply the anode material directly on the diamond layer. However, in the case of poor adhesion, an adhesion-promoting intermediate layer can be advantageous. An intermediate layer can likewise be advantageous when as far as possible monochromatic radiation needs to be emitted from the x-ray anode. In this case, the intermediate layer acts as a radiation filter and/or a monochromator.

[0017] Tests have further shown that, with the same radiation output, temperature-sensitive samples can be better examined with the x-ray anode according to the invention than with the comparison anode with a beryllium window. Due to the excellent thermal conduction of diamond, the temperatures on the side facing the atmospheric area are lower, which makes it possible to place the samples closer to the window. This in turn results in a better optical resolution.

[0018] An exemplary embodiment of the invention is described in greater detail below:

[0019] A polycrystalline diamond layer (1) with a thickness of 250 μm is deposited on an

auxiliary substrate using hot-filament CVD. After removing the auxiliary substrate, a tungsten layer (2) with a thickness of 6 μm is deposited on this diamond layer using physical vapor deposition (PVD). The tungsten layer covers the diamond layer completely. The x-ray source is mounted in the housing (4) of a commercial x-ray microscope by means of a clamp (3), with sealing washers (4) being used to ensure a stable vacuum. The only Fig. 1 shows this microfocus source in installed condition. X-radiation hv is produced by localized bombardment of the x-ray anode with electrons e^-. The maximum achievable radiation density is measured with this x-ray anode. If the diamond layer is replaced with a 500 μm thick beryllium layer under otherwise identical conditions, the radiation density of the x-radiation produced is reduced by a factor of 4. With a diamond layer thickness of likewise 500 μm, the radiation density achievable with the x-ray anode according to the invention would be even better, due to the improved heat dissipation.

Patent Claims

1. X-ray anode, characterized in that the anode material is located on a diamond window.
2. X-ray anode according to claim 1, characterized in that it is a polycrystalline diamond window.
3. X-ray anode according to claim 1, characterized in that the diamond window is a monocrystal.
4. X-ray anode according to at least one of claims 1 through 3, characterized in that the thickness of the diamond window is in the range of 50 μm to 2000 μm.
5. X-ray anode according to claim 4, characterized in that the thickness of the diamond window is in the range of 300 μm to 700 μm.
6. X-ray anode according to at least one of claims 1 through 5, characterized in that the anode material is a metal, an alloy or several layers of metal.
7. X-ray anode according to at least one of claims 1 through 6, characterized in that the anode material thickness is between 1 μm and 25 μm.
8. X-ray anode according to claim 7, characterized in that the anode material thickness is between 3 μm and 12 μm.
9. X-ray anode according to claim 8, characterized in that the anode material thickness is 6 μm.
10. X-ray anode according to at least one of claims 1 through 9, characterized in that the anode material completely covers the window.
11. X-ray anode according to at least one of claims 1 through 9, characterized in that the anode material partially covers the window.
12. X-ray anode according to at least one of claims 1 through 11, characterized in that an intermediate layer is provided between the x-ray anode and the diamond window.
13. X-ray anode according to at least one of claims 1 through 12, characterized in that the intermediate layer is an adhesion-promoting layer.
14. X-ray anode according to at least one of claims 1 through 13, characterized in that the intermediate layer is a radiation filter.
15. X-ray anode according to at least one of claims 1 through 14, characterized in that a temperature sensor is provided.

16. X-ray anode according to claim 15, characterized in that the diamond window is provided as a temperature sensor.

17. Process for manufacturing an x-ray anode, particularly for manufacturing an x-ray anode according to one of claims 1 through 16, characterized in that an auxiliary layer is coated with a diamond layer by means of chemical vapor deposition (CVD), and a metallic layer is deposited on this diamond layer.

18. Process according to claim 17, characterized in that the coating of the auxiliary substrate is carried out by means of hot-filament CVD or microwave CVD.

19. Process according to at least one of claims 17 through 18, characterized in that a diamond layer with a thickness of 50 μm to 1000 μm is deposited.

20. Process according to claim 19, characterized in that a diamond layer with a thickness of 300 μm to 700 μm is deposited.

21. Use of an x-ray anode according to at least one of claims 1 through 16 for x-ray units.

22. Use of an x-ray anode according to at least one of claims 1 through 16 for x-ray microscopes.

Abstract

The invention relates to an x-ray anode and a process for its manufacture. The x-ray anode is characterized in that the anode material is embodied as a layer on a diamond window. The x-ray anode is preferably used with x-ray units which require as selective as possible x-radiation production to achieve as high as possible radiation intensity. Use in x-ray microscopes in which a high radiation intensity guarantees the highest resolutions is particularly preferred.

10 - 030,133

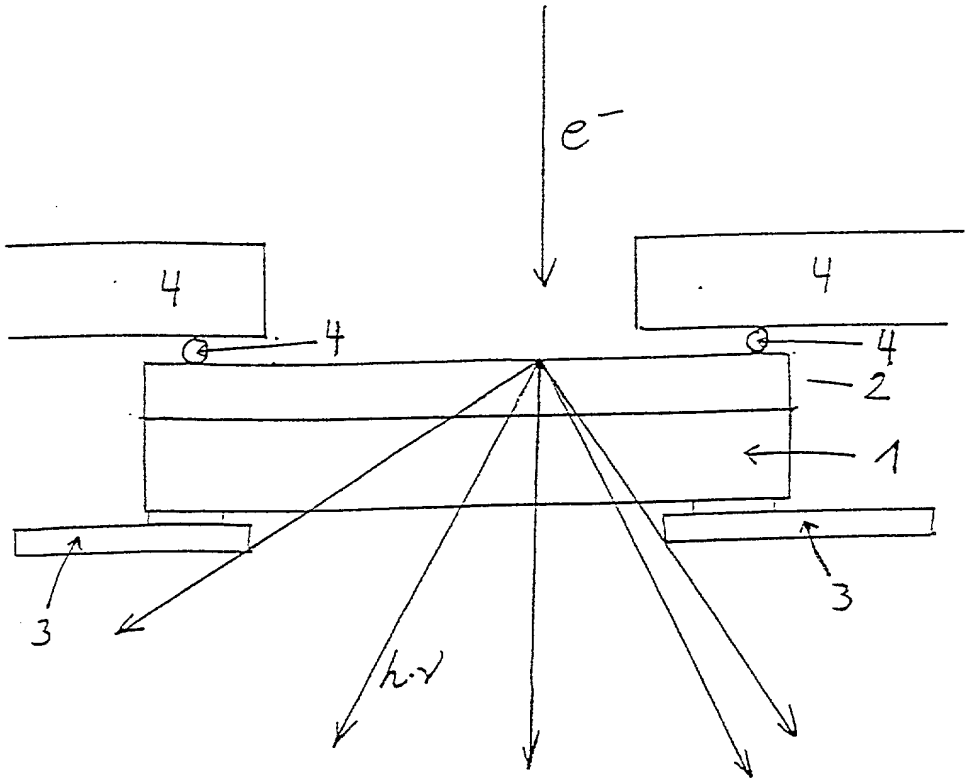


Fig. 1

Declaration and Power of Attorney For Utility or Design Patent Application

Erklärung für Patentanmeldungen zur Gebrauchseignung und Entwicklung mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent für die Erfindung mit folgendem Titel beantragt wird:

RÖNTGENANODE UND VERFAHREN ZU IHRER HERSTELLUNG

deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

■ wurde angemeldet am 24 Juli 2000
unter der US-Anmeldenummer _____
und wurde am _____ abgeändert (falls zutreffend)
oder

unter der PCT internationalen Anmeldungsnummer PCT/EP00/07076 und wurde am 5 September 2001 and 13. November 2001 abgeändert (falls zutreffend).

Ich bestätige hiermit, daß ich den Inhalt der oben angegebene Patentanmeldung, einschließlich der Ansprüche, die eventuell durch einen oben erwähnten Zusatzantrag abgeändert wurde, durchgesehen und verstanden habe.

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäß Title 35, US-Code, § 119 (a)-(d), bzw. § 365(b) aller unten aufgeführten Auslandsanmeldungen für Patente oder Erfinderurkunden, oder § 365(a) aller PCT internationalen Anmeldungen, welche wenigstens ein Land ausser den Vereinigten Staaten von Amerika benennen, und habe nachstehend durch ankreuzen sämtliche Auslandsanmeldungen für Patente bzw. Erfinderurkunden oder PCT internationale Anmeldungen angegeben, deren Anmeldetag dem der Anmeldung, für welche Priorität beansprucht wird, vorangeht.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

X-RAY ANODE AND PROCESS FOR ITS MANUFACTURE

the specification of which is attached hereto unless the following box is checked:

■ was filed on July 24, 2000 as United States Application Number _____ and was amended on _____ (if applicable)
or,

PCT International Application Number PCT/EP00/07076 and was amended on September 5, 2001 and November 13, 2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority under Title 35, United States Code §119 (a-d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States, listed below. I have also identified below, by checking the "No" box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed:

Prior Foreign Applications
Frühere ausländische Anmeldungen

(Number) (Nummer)	(Country) (Land)	(Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	Priority Claimed Prioritätsanspruch: Yes Ja	No Nein
199 34 987.8	Germany	26/July/1999	■	□
			□	□

□ Zusätzliche einstweilige Anmeldungsnummern sind im Prioritätsanhang aufgeführt.

□ Additional foreign application numbers are listed on a supplemental priority sheet attached hereto.

German Language Utility or Design Patent Application Declaration

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below.

(Application Number)
(Aktenzeichen)

(Day/Month/Year Filed)
(Tag/Monat/Jahr der Anmeldung)

(Application Number)
(Aktenzeichen)

(Day/Month/Year Filed)
(Tag/Monat/Jahr der Anmeldung)

(Application Number)
(Aktenzeichen)

(Day/Month/Year Filed)
(Tag/Monat/Jahr der Anmeldung)

☐ Zusätzliche einstweilige Anmeldungsnummern sind im ergänzenden Prioritätsanhang aufgeführt.

☐ Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

Ich beanspruche hiermit die mir unter Title 35, US-Code, § 120 zustehenden Vorteile aller unten aufgeführten US-Patentanmeldungen bzw. § 365(c) aller PCT internationalen Anmeldungen, welche die Vereinigten Staaten von Amerika benennen, und erkenne, insofern der Gegenstand eines jeden früheren Anspruchs dieser Patentanmeldung nicht in einer US-Patentanmeldung, bzw. PCT internationalen Anmeldung in in einer gemäß dem ersten Absatz von Title 35, US-Code, § 112 vorgeschriebenen Art und Weise offenbart wurde, meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Title 37, Code of Federal Regulations, § 1.56 von Belang sind und die im Zeitraum zwischen dem Anmeldetag der früheren Patentanmeldung und dem nationalen oder im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesen (PCT) gültigen internationalen Anmeldetags bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application No.)
(Aktenzeichen)

(Day/Month/Year Filed)
(Tag/Monat/Jahr eingereicht)

(Status)
(patentiert, schwebend, aufgegeben)
(patented, pending, abandoned)

(Application No.)
(Aktenzeichen)

(Day/Month/Year Filed)
(Tag/Monat/Jahr eingereicht)

(Status)
(patentiert, schwebend, aufgegeben)
(patented, pending, abandoned)

☐ Zusätzliche USA oder internationale Anmeldungsnummern sind im ergänzenden Prioritätsanhang aufgeführt.

☐ Additional U.S. or international application numbers are listed on a supplemental priority sheet attached hereto.

Ich erkläre hiermit, daß alle in der vorliegenden Erklärung von mir gemachte Angaben nach bestem Wissen und Gewissen der Wahrheit entsprechen, und ferner daß ich diese eidesstattliche Erklärung in Kenntnis dessen ablege, daß wissentlich und vorsätzlich falsche Angaben oder dergleichen gemäß § 1001, Title 18 des US-Code strafbar sind und mit Geldstrafe und/oder Gefängnis bestraft werden können und daß derartige wissentlich und vorsätzlich falsche Angaben die Rechtswirksamkeit der vorliegenden Patentanmeldung oder eines aufgrund deren erteilten Patentes gefährden können

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Hiermit bevollmächtigt der Unterzeichnete den hierin genannten entweder USA-Anwalt oder Stellvertreter, in der Abwesenheit einer direkten Verständigung zwischen den USA-Anwalt oder Stellvertreter und dem Unterzeichneten Anweisungen, die der der Anmeldung betreffend dem Patent und Warenzeichen Amt zugestellt werden, von entweder seinem ausländischen Patentvertreter oder Stellvertreter der Gesellschaft anzunehmen und auszuführen. Sollte sich das Personal ändern, von dem Anweisungen angenommen werden mögen, dann wird der hierin genannte USA-Anwalt oder Stellvertreter entprechend von dem Unterzeichneten benachrichtigt.

The undersigned hereby authorizes the U.S. attorney or agent named herein to accept and follow instructions from either his foreign patent agent or corporate representative, if any, as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorney or agent named herein will be so notified by the undersigned.

German Language Utility or Design Patent Application Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den sich mit der Kundennummer erfassenden Patentanwalt (Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent-und Warenzeichenamt und weise an, dass alle Korrespondenz mit dieser Kundennummer addressiert wird.

POWER OF ATTORNEY. As a named inventor, I hereby appoint the attorney(s) and/or agent(s) associated with the Customer Number provided below to prosecute this application and transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to that Customer Number:

KUNDENNUMMER 7055

CUSTOMER NUMBER 7055

Die ernannten Patentanwälte sind zur Zeit:

Neil F. Greenblum	Reg. No. 28,394
Bruce H. Bernstein	Reg. No. 29,027
Arnold Turk	Reg. No. 33,094
James L. Rowland	Reg. No. 32,674

The appointed attorneys presently include:

Stephen M. Roylance	Reg. No. 31,296
Leslie J. Paperner	Reg. No. 33,329
William Pieprz	Reg. No. 33,630
William E. Lyddane	Reg. No. 41,568

Address: **Greenblum & Bernstein, P.L.C.**
1941 Roland Clarke Place
Reston, VA 20191

Telefongespräche bitte richten an:

Direct Telephone Calls to:

Greenblum & Bernstein, P.L.C.
(703) 716-1191

Vor-und Nachname des einzigen oder ersten Erfinders: Matthias FRYDA	Full name of sole or first inventor Matthias FRYDA
Unterschrift des Erfinders Datum Dr. [signature] 24.1.02	Inventor's signature Date [signature] 24.1.02
Wohnsitz DEY Braunschweig, Deutschland	Residence Braunschweig, Germany
Staatsangehörigkeit Deutschland	Citizenship German
Postanschrift Eichendorffstrasse 14, D38110 Braunschweig, Deutschland	Post Office Address Eichendorffstrasse 14, D38110 Braunschweig, Germany
Vor-und Nachname des zweiten Miterfinders (falls zutreffend) Lothar SCHÄFER	Full name of second joint inventor, if any Lothar SCHAEFER
Unterschrift des zweiten Erfinders Datum Dr. Schäfer 24.1.02	Second Inventor's Signature Date Dr. Schäfer 24.1.02
Wohnsitz DEY Meine, Deutschland	Residence Meine, Germany
Staatsangehörigkeit Deutschland	Citizenship German
Postanschrift Moorweg 1, D-38527 Meine, Deutschland	Post Office Address Moorweg 1, D-38527 Meine, Germany
(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).	(Supply similar information and signature for third and subsequent joint inventors).

German Language Utility or Design Patent Application Declaration

300

Vor-und Nachname des dritten Miterfinders: Thorsten MATTHEE	Full name of third inventor, if any Thorsten MATTHEE
Unterschrift des dritten Erfinders Datum 24. Jan. 2002	Third Inventor's signature Date 24. Jan 2002
Wohnsitz Meine, Deutschland	Residence Meine, Germany DEP
Staatsangehörigkeit Deutschland	Citizenship German
Postanschrift Wiesenweg 11A, D-38527 Meine, Deutschland	Post Office Address Wiesenweg 11A, D-38527 Meine, Germany
Vor-und Nachname des vierten Miterfinders (falls zutreffend)	Full name of fourth inventor, if any
Unterschrift des vierten Erfinders Datum	Fourth Inventor's Signature Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address
Vor-und Nachname des fünften Miterfinders (falls zutreffend)	Full name of fifth inventor, if any
Unterschrift des fünften Erfinders Datum	Fifth Inventor's Signature Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address
Vor-und Nachname des sechsten Miterfinders (falls zutreffend)	Full name of sixth inventor, if any
Unterschrift des sechsten Erfinders Datum	Sixth Inventor's signature Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address
(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).	(Supply similar information and signature for seventh and subsequent joint inventors).